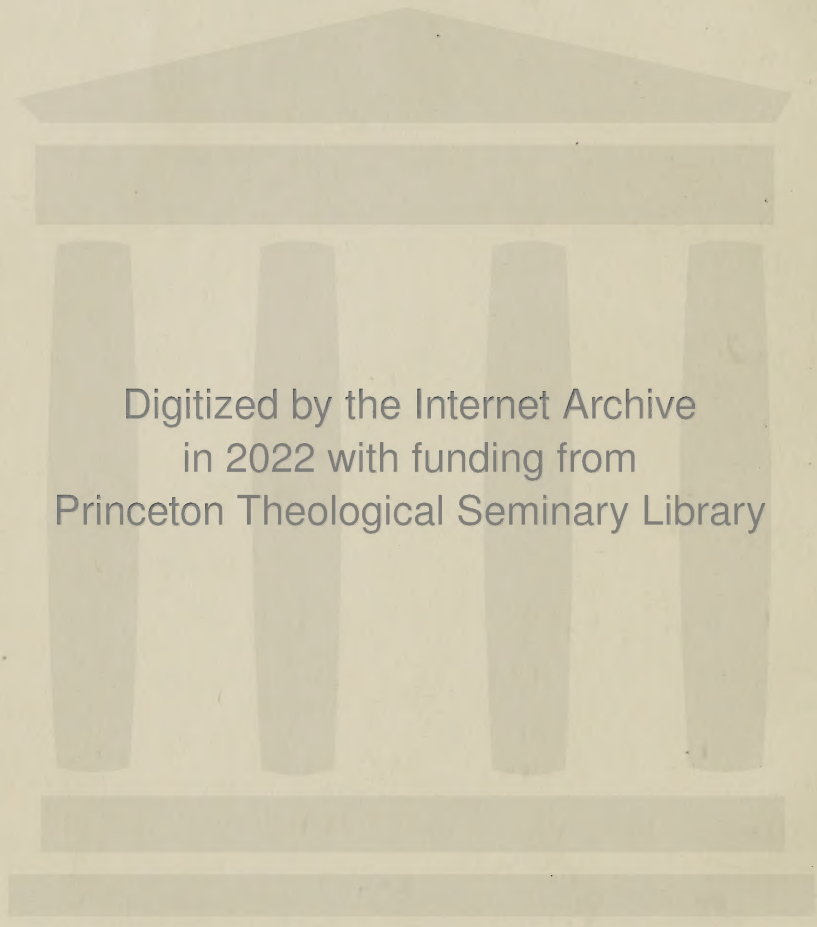

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The Influence of Tuition in the Acquisition of Skill

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CHAPTER I

Introduction

In almost all the work on learning the experiments are conducted in such a way that the subject performs the assigned task without any interference on the part of the experimenter during the period of learning. In the experimental work on memory, for instance, the subject is given some kind of material to learn; but in no case does the experimenter offer him any assistance or suggestion during either the process of memorizing or recall. In acquiring acts of skill, the subject does not receive any coaching from the experimenter during the period of practice. In learning a maze the subject is asked to master the problem in as short a time and with as few errors as possible. During any one trial or in any part of the experiment, he is given no aid. In fact, in most of the experiments on learning the experimenter purposely takes the precaution to avoid influencing the subject in any way either by word or manner.

On the other hand, the experimenter may purposely introduce some suggestion, advice or guidance from time to time, in order to study its effect upon the process of learning. Such an attempt on the part of the experimenter to give some assistance to the subject while learning may be called a process of tuition.

In human psychology the only work devoted exclusively to the study of the influence of tuition upon learning is that of Miss Ludgate on "The Effect of Manual Guidance upon Maze Learning."[1] Tuition was given in the form of manual guidance. The experimenter guided the subject's hand over the correct pathway of the maze for a given number of trials and let him complete the learning without further assistance. She found that such guidance was helpful in most cases. In the field of animal psychology the tuition method has been used by Thorndike.[2] He put his cats through some problem boxes, but concluded that this

[1] Ludgate, Katherine E., "The Effect of Manual Guidance upon Maze Learning." Psychological Review Monograph Supplement, Vol. XXXIII, No. 148.
[2] Thorndike, Edward L., "Animal Intelligence," Psychological Review Monograph Supplement, Vol. II, No. 4.

mode of tuition was not very successful. Lashley,[3] in the study of the relation of the distribution of practice to the rate of learning adopted the tuition method in one case in which "the animals were not allowed to correct the errors but were returned immediately to the starting compartment if they entered a *cul de sac* or turned back along the correct path." Here tuition did produce a beneficial effect.

The purpose of the present investigation was to study the influence of verbal means of tuition upon maze learning. Two forms of tuition were employed: (1) The method of Instruction and (2) The method of Information. In the first method, the subject was guided over the correct pathway by being told in which direction to move the stylus, in order to discover the effect of error prevention upon the ability to learn the maze. In the second method, the subject was informed of each error as it was made in order to ascertain whether a knowledge of one's mistakes will aid in their elimination. This information was imparted in one of three ways: (1) By counting after the completion of each error: The subject was informed that the experimenter would count aloud each error just after it was made. (2) By counting at the beginning of each error: In this case the experimenter counted aloud just as the subject started to enter a *cul de sac* or to return over the true path. (3) By naming each error after it was made. The experimenter called out 'blind' for each entrance into a *cul de sac* and 'backward' for each return over a section of the true pathway. Care was taken to prevent all other sources of suggestion beyond those enumerated. No other verbal comment of any sort was made while the maze was being mastered. All visual sources of suggestion were eliminated by the use of a screen which entirely shielded the experimenter from the sight of the subject.

Problems

The problems involved in this investigation may be set forth in the following series of propositions:

(1) To study the influence of tuition in maze learning by com-

[3] Lashley, K. S., "A Simple Maze: with Data on the Relation of the Distribution of Practice to the Rate of Learning," Psychobiology, Vol. 1, No. 5.

paring the results of the groups which learned the maze with a given amount of tuition with those that mastered the maze without such aid.

(2) To determine the relative efficiency of the various forms of verbal tuition used in this investigation.

(3) To study the relative effect of different amounts of tuition upon learning.

(4) To investigate the effect of introducing tuition at various positions during the process of learning.

(5) To study individual and sex differences in learning.

Apparatus

The apparatus was the stylus maze (see FIG. 1) used by Miss

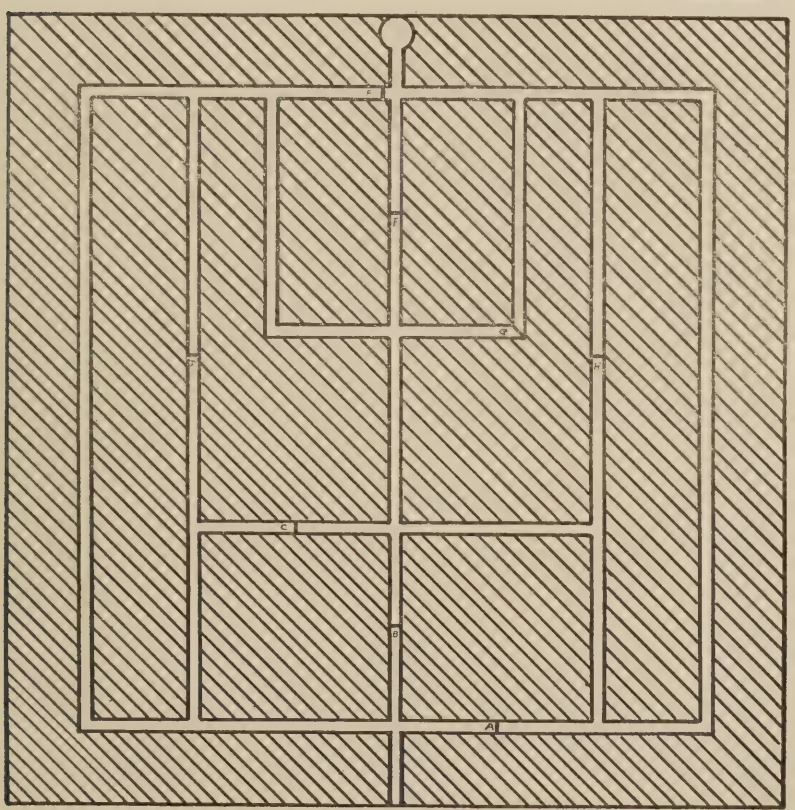

FIGURE I

Ludgate in her research referred to above. Its dimensions were 41.5 cm. by 42.0 cm. The correct pathway had length of 174 cm. and the blind alleys, 119.3 cm. The stylus consisted of a small circular disc, 2 cm. in diameter, which was attached to the hard rubber handle by a ball and socket joint. The maze was so constructed that the stylus could not be removed from the grooves except at the entrance or at the goal end. The stylus was inserted in the groove at the entrance and the subject was instructed to discover the location of the goal end. When the goal was reached, thus marking the end of a trial, the stylus was removed from the groove and placed back at the starting point for the next trial. The maze was firmly fastened to a small table. Over it was erected a square wooden framework of a height of about 40 cm. The whole frame was covered with black canvas save on the side towards the experimenter. This arrangement hid the maze and the experimenter from the sight of the subject, but allowed the experimenter to watch the subject's movements while mastering the maze.

Procedure

Three hundred and fifteen subjects mastered the maze under twenty-six different conditions. Almost all of the subjects were drafted from the classes of introductory psychology. A great majority of them were either sophomores or juniors in the university. All were without any previous maze experience.

Before each subject started the experiment, a typewritten sheet of General Instructions and another sheet of Special Instructions for his particular group were handed to him. Only the General Instructions sheet was given to the members of the normal group. The subject was requested to read the Instructions carefully and to delay the beginning of the experiment until he thoroughly understood them. The General Instructions follow:

"When the experiment begins, sit squarely in front of the table as closely as convenient. Place your hand beneath the curtain and I will give you a stylus. Use either hand you prefer. Hold the stylus in the vertical position and do not allow your hand to come in contact with the maze during the course of the

experiment. The stylus moves freely in the grooves of the maze. There is but one place in the maze where the stylus can be lifted out of the groove. The object of each trial is for you to move the stylus about in the grooves, exploring all paths in the attempt to discover this place with as few moves as is possible. I will inform you when you reach this position, in case you do not recognize it. There is but one correct route from the beginning of the maze to this goal and the route remains constant from trial to trial. In addition to the correct pathway there are a number of blind alleys. Any entrance into a blind alley, and any retracing of the correct path will be counted as an error. The object of the experiment is to learn in as few a number of trials as is possible to move the stylus over the correct path without making any error. The maze will be considered learned when you are able to make four correct trials in succession. Use any speed you prefer. Speed does not count in the records."

The Special Instructions for each group will be given later.

As soon as the subject started to work, the experimenter refrained from any kind of utterance, except that which has been specified. The screen eliminated all possibilities of suggestion from the experimenter's facial expression or bodily movements. The subject was required to finish the experiment in one sitting. Between trials a rest of a few seconds was always required. Brief periods of rest were also permitted during the long initial trials. These intervals of rest were interpolated at the discretion of the experimenter.

The subjects were required to master the maze until they were able to run four perfect trials in succession. For each trial there were recorded the time in seconds, the total number of errors, the number of *cul de sac* and return errors, and the number of errors made for each *cul de sac*. Some of the detailed data were desired for the study of individual differences. It was purposely stated in the General Instructions sheet that "speed does not count" so as to allow full play to the individual's peculiarities in the time record.

The experimental conditions were kept as nearly constant as possible. The experiments were always conducted in the same

room and at various times during the day. In order to minimize the diurnal effect, the time of experimentation for the subjects in any one group was distributed as widely as possible throughout the day. The possibility of sex differences was also taken into account and minimized by distributing as equally as possible the number of both sexes in any group.

Group Notations

In order to avoid confusion, the various groups of subjects were given different notations. Capital letters indicated the kind of tuition employed; numerals, the amount given; and small letters, the position in which it was given. Thus A-1-a, for example, means that the A form of verbal suggestion was given during the first trial only.

The notations for the different groups are:

N = Normal group in which no tuition was employed.

D = Groups where verbal instructions were given.

A, B, and C = Three modes of giving information (A = counting at the completion of each error; B = counting at the point of making each error; C = naming each error after it was made.)

CHAPTER II

The Instructional Method of Tuition

The experiments reported in this chapter were conducted in order to ascertain the effect of guidance by means of verbal instructions upon the process of learning a stylus maze. By means of these instructions the subjects were guided over the correct pathway for a given number of initial trials, and thereafter they were required to complete the learning of the maze without any further aid. This procedure prevented the subjects from making any error during the guided trials and the experiment was designed to study the effect of this initial guidance upon the subsequent unguided trials.

Five groups of ten subjects each received different amount of verbal instruction during the initial trials. They are designated as the controlled groups. The conditions under which these groups learned the maze are summarized in the following table:

TABLE 1

Conditions for the Controlled Groups

Group Designation	No. of Subjects	No. of Initially Guided Trials
D-1 -a	10	1
D-2 -ab	10	2
D-4 -abcd	10	4
D-8 -a...h	10	8
D-16-a...p	10	16

For all of the controlled groups the typewritten General Instructions were read by the subject. In addition to this a typewritten sheet of Special Instructions was also read by each subject. The Special Instructions for the different groups were the same except that the number of the guided trials was specified differently for each group. The Special Instructions sheet for group D-1-a is given as an example:

"In your case, I shall give you *during the first trial only* verbal instructions while running the maze, which if followed carefully

will enable you to run the maze without error. As you approach a critical point in the maze, I will say aloud 'right,' 'left,' 'forward' or 'backward' as the case may be. In case you make an error in spite of the instructions, I will say 'turn back.' If you go relatively slowly, and follow the instructions carefully, no error will be made. The purpose of this experiment is to discover whether these instructions given for a certain number of trials will enable you to run the maze more readily than you would without them."

The results of these controlled groups are to be compared with those of a group of fifteen subjects, who learned the same maze without any verbal instructions. This group is known as the normal (N). These results can also be compared with some of Miss Ludgate's data in order to study the relative effect of verbal and manual guidance.

Two problems will thus be investigated in this chapter.

1. Is the method of error-prevention by means of verbal instructions an aid in learning? What is the relationship between the amount of verbal instruction and the degree of its effectiveness?

2. What is the relative value of verbal and manual means of guidance?

1. *The Effect of Verbal Instruction upon Learning*

The comparative data for the first problem are given in tables 2 and 3. Table 2 gives the average scores per individual for trials, the number of retracing and *cul de sac* errors, the total number of errors, the average number of errors per trial, and the final speed in seconds (*i.e.,* the average speed for the last four trials). In this and in all the later tables the individual variability within a group is expressed in terms of M.D. Table 3 gives the percentages of saving for each of these items for each of the controlled groups.

TABLE 2

Records of Normal and Controlled Groups

Groups	Trials	Errors			Errors per Trial	Final Speed
		Retrac.	Blind	Total		
N	31.6 ± 9.33	67.4	138.7	206.1 ± 88.91	7.11	12.68 ± 1.64
D-1 -a	21.9 ± 4.90	31.9	78.7	110.6 ± 82.64	4.21	25.70 ± 17.22
D-2 -ab	19.0 ± 7.00	15.4	40.8	56.2 ± 56.28	2.25	22.23 ± 7.65
D-4 -abcd	16.5 ± 7.26	5.6	14.0	19.6 ± 17.44	1.03	26.80 ± 12.79
D-8 -a...h	28.2 ± 7.40	8.5	26.1	34.6 ± 24.96	1.14	23.42 ± 7.83
D-16-a...p	33.0 ± 7.60	8.8	16.8	25.6 ± 19.40	0.69	24.90 ± 10.54

TABLE 3

Percentages of Saving Due to Verbal Instructions

Groups	Trials	Errors	Errors per Trial	Final Speed
N	.....	.....	.....	.....
D-1 -a	30.82%	50.71%	40.93%	—102.68%
D-2 -ab	39.98	72.73	68.35	— 75.31
D-4 -abcd	47.88	90.48	85.51	—111.36
D-8 -a...h	10.92	83.22	83.96	— 84.70
D-16-a...p	—4.23	87.58	90.29	— 96.37

The factual data may be summarized as follows:

(1) With one exception verbal guidance operated to decrease the number of trials required to learn the maze, the total number of errors, and the average number of errors per trial. It increased the record for the final speed.

(2) On the average, verbal guidance affected the score for the final speed most, the error record next, and the trial record least. The records of the guided groups showed a saving of 76.94% and 25.49% respectively for errors and trials, and a loss of 94.08% on final speed.

(3) The efficacy of the guidance as measured by the trial and error records varied with the amount of guidance given. In a general way, its effectiveness at first increased and then decreased, as the number of the guided trials was increased. When the ef-

ficiency of the guidance was measured by the record for the final speed, there was no definite relationship between the amount of guidance and the degree of its effectiveness. Four guided trials was the most effective number employed. It exerted the most effect upon the records for trial, error and final speed.

(4) Guidance exerted a slightly greater effect upon the amount of retracing than it did upon the number of entrances into the *cul de sacs.*

(5) Guidance increased the relative amount of individual variability in the records for error and final speed. No consistent effect upon the trial records can be noted.

The pronounced effect of the guidance upon the error record is due in the main to the fact that no errors were made during the guided trials. The saving in errors due to the immediate effect of guidance is given in the fourth column of Table 4. As one would naturally expect, the number of errors prevented increases with the number of the guided trials.

TABLE 4

Error Reduction Due to Guidance

Groups	Total Errors	Total Saving	Saving during Guidance	Saving after Guidance
N	206.1	.....	....	....
D-1 -a	110.6	95.5	79.1	16.4
D-2 -ab	56.2	149.9	101.8	48.1
D-4 -abcd	19.6	186.5	137.9	48.6
D-8 -a...h	34.6	171.5	168.9	2.6
D-16-a...p	25.6	180.5	191.5	—11.0

Guidance also exerted an effect upon the error records of the subsequent period of learning. This is apparent from an inspection of tables 4 and 5. The fifth column of table 4 gives the total number of errors saved for each guided group during the post-guided period of learning. Four guided trials exerted the greatest effect, while the influence of sixteen guided trials was detrimental.

TABLE 5

Error Records for the First Twenty Trials

Trials	N.	D-1-a	D-2-ab	D-4-abcd	D-8-a..h	D-16-a...p
1	79.1	0	0	0	0	0
2	22.7	24.5	0	0	0	0
3	16.5	20.4	10.1	0	0	0
4	19.6	20.7	5.2	0	0	0
5	6.3	9.9	4.8	2.6	0	0
6	12.9	7.4	8.6	3.2	0	0
7	6.2	3.5	2.9	2.6	0	0
8	5.6	5.5	2.0	1.6	0	0
9	2.8	2.3	3.4	.8	10.6	0
10	3.2	2.9	1.5	.9	2.1	0
11	2.9	1.6	1.2	.7	2.7	0
12	3.8	1.2	3.2	.7	1.9	0
13	3.4	1.7	1.0	.6	1.1	0
14	2.8	1.1	1.0	.4	.7	0
15	2.1	.7	.9	.2	2.0	0
16	1.6	.8	1.1	1.4	1.7	0
17	1.7	.4	.5	.6	.7	3.5
18	1.4	.1	.5	.5	.7	1.6
19	1.6	1.1	.3	1.1	1.4	1.1
20	.6	.5	.6	0.0	.7	.6

In table 5 are given the error records of the various groups for the first twenty trials. It will be noted that the groups given 2 and 4 guided trials have an initial error record which is lower than that of the normal group after a similar number of unguided trials. In other words, groups given 2 or 4 guided runs reach a more advanced stage in the mastery of the problem than they would have attained if allowed a similar number of unguided runs. On the other hand, the groups given 1, 8 and 16 guided trials made a poorer initial error record than did the normal group after a corresponding number of unguided trials.

It is evident that the subjects learned a considerable amount about the maze during the guided trials, and that this knowledge was utilized effectively in completing the mastery of the problem during the post-guided period of learning.

Subjects can learn more from 1 to 8 guided trials than they can from an equal number of unguided runs. Sixteen guided trials, however, are less effective than sixteen unguided ones.

The fact that the effectiveness of the guidance first increased and then decreased with the number of trials in which it was given can be explained in the following manner: Guidance is effective because it enables the subject to acquire a knowledge of the nature of the true pathway. Only so much can be acquired in this manner and after this limit has been reached, any additional guidance will be superfluous and possibly detrimental. (1) All superfluous trials will necessarily increase trial and error records. (2) Any excessive amount of guidance is apt to develop either an attitude of over-confidence or a habit of dependence. Over-confidence leads to carelessness and many unnecessary errors are made and more trials are required for their elimination. The subject develops the habit of relying upon the experimenter, and becomes confused and helpless when thrown upon his own resources. Extra time is required in order to adjust to the new situation.

That guidance exerted a slightly greater effect upon the amount of retracing than it did upon the number of entrances into the blind alleys can be explained by the fact that it gave the subject a knowledge of the general direction of the correct pathway, which favored the elimination of the retracing errors. On the other hand, this knowledge of the general direction did not insure the elimination of *cul de sac* errors to the same extent.

That guidance operated to decrease the final speed for all the controlled groups can be accounted for by the fact that it induced within the subjects an attitude of caution which means delay in movement. In the cases in which a very small amount of guidance was given, this attitude developed during the period of guidance persisted in the subsequent trials, and thus decreased the final speed. When a large amount of guidance was given, it strengthened this attitude to such an extent that the subjects were accustomed to go slowly around the maze.

That verbal guidance tended to increase the relative variability of the groups in the records for error and final speed may be accounted for by the fact that individual differences in the ability to learn the maze were emphasized to a greater extent with guidance than without. The range between the best and the poorest learn-

ers in the normal group is far smaller than that in most of the controlled groups.

2. The Relative Value of Verbal and Manual Guidance

Since the maze employed in our investigation was the one which had previously been used by Miss Ludgate, it is possible to compare the value of the two methods of guidance. Five groups of subjects in each experiment were given similar amounts of guidance. The comparative data are given in table 6. "Manual" refers to Miss Ludgate's data and "Verbal" to ours.

Miss Ludgate used as her criterion of learning the ability to make four perfect runs in five attempts. Our criterion is four perfect successive trials. In order to make the conditions comparable, we have computed our data as given in table 6 on the same basis as that employed by Miss Ludgate. This procedure accounts for the fact that our records as given in table 6 differ slightly from those given in table 2.

TABLE 6
The Relative Value of Verbal and Manual Guidance

No. of Guided Trials	Trials		Errors	
	Manual	Verbal	Manual	Verbal
0	28.8	27.9	194.5	203.66
2	23.2	18.8	53.4	56.2
4	29.1	15.8	72.0	19.6
8	27.5	25.3	69.8	33.6
16	41.1	27.8	43.2	22.4

The results for the two normal groups, those to whom no guidance was given, are approximately identical. This fact indicates that the comparison of the two sets of data is legitimate.

The verbal method of guidance is the more effective with the single exception of the error record for the group with two guided trials.

The two methods differ in the number of trials required to secure the optimal effect. With manual guidance, two trials exert the greatest effect, while four trials are required for the verbal method.

These results must be explained in terms of the differences between the two methods. In Miss Ludgate's experiment, the subject grasped the stylus and the experimenter moved it over the correct pathway at a uniform rate. The subject was requested to maintain as *passive* an attitude as possible. The experimenter was responsible for the motion of the stylus. Our subjects assumed an *active* attitude. They voluntarily initiated and executed the movements in response to our direction. The rate of motion was subject to their discretion.

The greater effectiveness of the verbal method of guidance is to be explained in terms of this difference of volitional attitude toward the task. It is assumed that a subject will learn more about the nature of the requisite arm motion when it is actively performed than when it is passively executed.

The fact that the two methods differ as to the number of trials required to develop their maximum effectiveness can be explained in two ways: (1) We may assume that very much more can be learned about the true path with the active method of traversing it, and hence that more trials are required to attain this limit of effective knowledge in spite of the greater efficiency of each trial. (2) The manual or passive method is more conducive to the development of the attitudes of carelessness and dependence upon the experimenter. These attitudes are developed more quickly, and as a consequence their detrimental effects begin to manifest themselves after a fewer number of trials.

CHAPTER III

The Informational Method of Tuition

With the informational method of tuition, three groups of fifteen subjects each were employed. These groups are known as A, B, and C respectively. Group A was given the first form of the information method; Group B, the second; and Group C, the third. In all cases the information concerning their errors was imparted during every trial involved in learning the maze. The Special Instructions given to the members of each group were as follows:

Group A: "In your case, I shall count out loud the number of errors as you make them. I shall count after you have completed the error—after you have reached the end of a blind alley, or after you have traversed the full length of a straight section when retracing the correct path. This procedure will inform you of every error after you make it. The purpose of the experiment is to discover whether this knowledge will enable you to learn the maze more readily."

Group B: "In your case, I shall count out loud the number of errors as you make them. In each case I shall count just as you start to make the error, *i.e.*, just after entering a blind alley and whenever you start to retrace over the correct path. This procedure will inform you of every error just as you are beginning to make it. The purpose of the experiment is to discover whether this knowledge will enable you to learn the maze more readily."

Group C: "In your case, I shall inform you of every error you make, whether the error is an entrance into a blind alley or a return over the correct path. I shall say 'blind' after you have reached the end of blind alley, and 'backward' after you have retraced the full length of a straight section of the maze. The purpose of this experiment is to discover whether this knowledge will enable you to learn the maze more readily."

The results of the above groups are compared with those of the normal group of fifteen subjects who learned the maze without assistance. The comparative data are given in tables 7, 8,

and 9. Table 7 gives the gross records, table 8 the percentages of saving resulting from those means of tuition, while in table 9 are found the error records for the first fifteen trials.

TABLE 7

Records of Normal and Controlled Groups

Groups	Trials	Errors			Final Speed
		Retracing	Blind	Total	
N	31.66 ± 9.33	67.4	138.7	206.13 ± 88.91	12.68 ± 1.64
A	22.27 ± 8.32	28.8	74.3	103.2 ± 63.22	21.81 ± 8.16
B	24.93 ± 7.38	20.7	58.2	78.9 ± 40.66	20.64 ± 7.58
C	21.33 ± 7.37	18.1	42.1	60.2 ± 28.66	25.36 ± 9.95

TABLE 8

Percentages of Saving due to a Knowledge of Errors

Groups	Trials	Errors		Final Speed
		Retracing	Blind	
N	.....	.....	.....	.....
A	29.65%	57.27%	46.43%	—72.01%
B	21.25	69.28	58.03	—62.77
C	32.62	73.14	69.64	—100.00

TABLE 9

Error Records for the First Fifteen Trials

Trials	Normal Group			Group A			Group B			Group C		
	R	B	T	R	B	T	R	B	T	R	B	T
1	32.1	46.1	78.2	14.5	27.3	41.8	5.1	10.7	15.8	4.9	10.8	15.7
2	7.8	14.8	22.6	6.5	12.7	19.2	4.0	8.1	12.1	4.6	8.1	12.7
3	5.5	11.1	16.6	2.1	5.8	7.9	1.8	6.4	8.2	1.8	4.4	6.2
4	7.7	12.6	20.3	1.1	4.3	5.4	3.5	6.7	10.2	1.4	4.3	5.7
5	1.4	4.9	6.3	0.1	2.1	2.2	1.8	4.2	6.0	1.6	4.1	5.7
6	3.9	9.1	13.0	1.3	3.3	4.6	2.1	5.3	7.4	1.0	3.6	4.6
7	1.8	4.5	6.3	0.1	1.1	1.2	0.4	1.7	2.1	0.5	2.0	2.5
8	1.3	4.3	5.6	0.1	1.4	1.5	0.5	1.9	2.4	0.6	1.9	2 5
9	0.4	2.5	2.9	0.0	1.2	1.2	0.4	2.1	2.5	0.3	1.9	2.2
10	0.5	2.5	3.0	0.3	1.8	2.1	0.2	1.0	1.2	0.2	1.5	1.7
11	0.3	2.6	2.9	0.0	0.6	0.6	0.1	1.3	1.4	0.07	0.5	0.57
12	0.9	3.0	3.9	0.07	1.2	1.27	0.3	0.9	1.2	0.1	0.8	0.9
13	0.8	2.9	3.7	0.07	1.0	1.07	0.2	1.0	1.2	0.2	0.7	0.9
14	0.9	1.9	2.8	0.2	1.07	1.27	0.0	4.1	4.1	0.07	0.8	0.87
15	0.2	1.9	2.1	0.07	0.9	0.97	0.07	6.0	6.07	0.07	0.7	0.77

R—Retracing; B—Blind Alley; T—Total.

The experiments were designed to answer two general questions: (1) To what extent will this information be utilized in learning the maze? Will a knowledge of one's mistakes obtained in this manner be of any aid in their elimination? (2) What is the relative value of the three forms of the informational method?

The comparative data of the above tables justify the following conclusions:

The information imparted to the subjects concerning the errors operated to decrease the records for trials and errors. But it retarded the final speed.

This knowledge exerted the greatest effect upon the records for the final speed, next upon the error records, and least upon the trial records.

The information exerted a slightly greater effect upon the errors due to retracing than upon those due to entrances into the *cul de sacs*.

It is a noteworthy fact that this information very materially reduced the number of errors in the first trial. For the three groups A, B and C, the percentages of saving in the first trial were 46.5, 79.8 and 79.9. The corresponding percentages for the entire period of learning were 49.98, 61.22 and 70.79.

These methods of information exerted no consistent effect upon the relative amount of individual variability within a group.

The third type of information (Method C) was the most effective, when measured in terms of trials, errors and final speed.

Method B was more effective than A in reducing the error record but less effective in decreasing the number of trials required to learn the problem and the average final speed employed to go over the correct path. The greater effectiveness of method B upon the error records was manifested in the initial trial.

In the usual method of learning the maze, errors may apparently be made and eliminated without any ideational knowledge of their existence. On the other hand, in the controlled groups, especially in the later stages of learning, the subject does come to recognize many of his errors, and presumably this knowledge of one's mistakes will aid in their elimination. To what extent errors are made and eliminated without knowledge and to what

extent their elimination is due to this knowledge we do not know.

Our experiments, however, do prove that such knowledge may be used effectively, for any information imparted to the subjects in addition to that which they discover on their own initiative very materially reduces the time required to learn. The members of the controlled groups who were informed of each error at the time it was made were able to master the problem much more readily than those subjects who were given no aid.

One may also infer from these records that many of the errors made in the normal method of learning the maze are wholly unnecessary. In other words, many might be dispensed with without affecting the number of trials required to master the problem. This hypothesis is supported by the fact that the information given to the subjects operated to reduce the error record much more than it affected the number of trials.

In the usual method of learning, the subjects, in their retracing excursions, naturally return a considerable distance toward the entrances to the maze. The information very materially reduces the distance of these returns, for the subjects naturally turn back when informed of their error. Since a section of the path constitutes the unit of error, the information will necessarily reduce the number of the retracing errors. Since *cul de sac* errors may be made while retracing and again while retraversing the section that has just been retraced, it is evident that any prevention of retracing will also reduce the number of entrances into the *cul de sacs*. With much retracing the subject becomes confused, lost and helpless, and many additional errors are made as a result of this confusion. This information serves the purpose at least of reducing the extent of the retracing excursions and thus incidentally affects the number of both types of error. This conception probably explains the fact that tuition was effective during the initial trial.

In learning a maze, other things being equal, the oftener one goes through it, the faster he travels. In the normal group, the subject on the average went through the maze thirty-two times before they mastered it, while in the controlled groups the number was about twenty-three. Naturally the final speed for the

former is greater than that for the latter. There is also another way of accounting for this difference. In the normal group the subject performs the task on his own accord. In the controlled groups the subject is constantly reminded of the mistakes as they are made. This outside influence tends to make him work more carefully. Caution implies hesitancy in work which in turn means slow movement and low speed.

Methods A and C are alike except that in the latter case the subjects are given the additional information as to the kind of error made. This additional knowledge accounts for the greater effectiveness of the latter method of tuition.

Methods A and B differ as to the time when the information was given. In the first case, the information was imparted at the end of a runway,—after the error was completed. In the latter method, the information was given just as the runway was entered. The two methods induced different attitudes on the part of the subjects. The information, when imparted at the end of *cul de sac,* will naturally exert no immediate effect upon the subject's behavior. This procedure develops more or less an attitude of indifference. When the information is given at the entrance of a *cul de sac,* the subjects immediately react by inhibiting the movement. This procedure develops an attitude of caution. The subjects attempt to anticipate and avoid these errors. This difference in attitude may account in part for the greater effectiveness of method B. A second explanation may also be suggested. In order to be effective in preventing an error, the information must be associated with the act of approaching it. The greater effectiveness of method B may be due to the fact that the information is imparted at a more opportune moment. The association is more readily established because of the closer temporal connection of the two factors. The study of the information method of tuition will be continued in the next four chapters, each taking up a special phase. Only the first type of information (method A) will be employed; the other two were discarded on various grounds. Method C was discarded on the ground that the terms "blind" and "backward" may be unconsciously confused. Method B was discarded on account of the greater difficulty of administration.

CHAPTER IV

Effect of Various Amounts of Information

In this chapter we shall report the experiments primarily concerned with the study of the effect of giving verbal information during a variable number of initial trials.

The 'A' form of verbal information—counting errors when completed—was used throughout.

Four groups of subjects were used in the experiments, two having ten each and two, fifteen. They mastered the maze under various conditions. In every case the subject received the verbal information concerning his errors during a given number of initial trials, and then completed the problem without further aid from the experimenter. A group of ten subjects received the information during the first trial only and it was designated as A-1-a. A second group of fifteen subjects was given the information during the first two trials; this was designated as A-2-ab. A third group of fifteen subjects learned the maze with the aid of verbal information during the first eight trials, this being designated as A-8-a..h. A fourth group of ten subjects received the verbal information during the first twelve trials. This was designated as A-12-a..l. The Special Instructions Sheet for each group was the same as that for group A except that the number of trials during which the verbal information was imparted, was specified in each case.

The results of each of these groups were compared with those of the normal group of fifteen subjects who learned the maze without any kind of information concerning their errors. The comparative data are given in tables 10 and 11. Table 10 gives the gross records for all these groups and table 11 shows the percentages of saving for each of the controlled groups over the normal group.

TABLE 10

Effect of Verbal Information Upon Learning

Groups	Trials	Errors			Final Speed
		Retracing	Blind	Total	
N	31.66 ± 9.33	67.4	138.7	206.13 ± 88.91	12.68 ± 1.64
A- 1-a	20.9 ± 8.68	42.7	94.3	137.0 ± 83.6	18.70 ± 3.95
A- 2-ab	20.4 ± 7.54	34.8	74.7	109.4 ± 54.86	18.17 ± 4.24
A- 8-a..h	18.2 ± 5.58	20.6	67.5	88.1 ± 23.34	22.74 ± 5.79
A-12-a..l	26.7 ± 9.36	33.2	90.4	123.6 ± 51.56	14.17 ± 3.77

TABLE 11

Percentages of Saving of Controlled Groups over Normal Group

Groups	Trials	Errors		Final Speed
		Retracing	Blind	
N	.....	.....	.....	.....
A- 1-a	33.98%	36.64%	32.01%	—47.47%
A- 2-ab	35.56	48.36	46.14	—43.29
A- 8-a..h	42.51	69.27	51.33	—79.33
A-12-a..l	14.81	65.57	34.82	—11.75

Two main problems will be considered in this chapter:

(1) Is the method of verbal information an effective aid in learning the maze, irrespective of the amount?

(2) What is the relative efficiency of the various amounts of verbal information?

The factual data may be summarized as follows:

(1) Verbal information, whatever the amount, imparted to the subjects, was effective in decreasing the number of trials required to master the maze, the total number of errors and retarding the final speed.

(2) It exerted the greatest effect on the final speed, next on error, and least on trial.

(3) It affected the retracing errors more than the *cul de sac* errors in the majority of cases.

(4) The group that learned with the aid of verbal informa-

tion during the first eight trials showed the best records in trial and error but the poorest in the final speed. Groups which received the information during either a fewer or greater number of trials made poorer records. The former excelled the latter in the number of trials required to master the problem but not in the total number of errors.

(5) There was no consistent relationship between the amount of verbal information received and the respective records for the final speed.

The superiority of the records of the verbal information groups over that of the normal group may be accounted for by two possible influences of the information: (1) the immediate and (2) the subsequent. These influences can be brought out by comparing the number of errors per trial in the controlled and uncontrolled periods with the corresponding data for the normal group. The following table gives these comparisons:

TABLE 12

Immediate and Subsequent Effect of Verbal Information

Groups	No. of Errors per Trial in					
	Controlled Period			Uncontrolled Period		
	No.	Cor. No. in N.	Saving	No.	Cor. No. in N.	Saving
A- 1-a	27.60	79.07	65.09%	5.49	4.1	—33.91%
A- 2-ab	24.26	50.86	52.28	3.31	3.5	5.96
A- 8-a.h	9.97	21.21	54.15	1.01	1.5	34.41
A-12-a.l	7.67	15.19	49.54	2.14	1.2	—78.33

For example, the group given information for the first two trials (A-2-ab) made an average error record of 24.26 per trial during the period in which the information was given, and an average error of 3.31 per trial for the subsequent period of learning. The error data of the normal group for the corresponding trials were 50.86 and 3.5 respectively. The percentages of saving due to the information are thus 52.28 and 5.96 for the two periods.

It is evident from table 12 that the immediate effect of the information is always beneficial. The percentages of saving apparently tend to decrease to a slight extent as the number of trials in which the information is given is increased. The subsequent effect of the information is sometimes beneficial and sometimes detrimental. Its effect varies in a pronounced manner with the amount of information given. Its influence is detrimental when the amount of information is either too little or too great.

The relative efficiency of varying amounts of information is a function of the combined influence of its immediate and subsequent effects. When both the immediate and the subsequent effects are beneficial, the combined effect always produces a better record than either one would alone. When the subsequent effect is detrimental, it becomes the controlling factor in determining the relative efficiency of these groups. Hence, A-8-a..h is the most efficient group not only because the combined effect is greater, but also because the subsequent effect is more beneficial than that of any other group. Group A-12-a..l is the least efficient, because the detrimental effect of the information on the subsequent uncontrolled trials is very much greater in this group than in any other one.

As a matter of fact in considering the relative efficiency of the controlled groups, we can easily dispense with the immediate effect of the verbal information, since this effect for each group is more or less on a par. The efficiency of a group is practically determined by the degree of the subsequent effect of the information. The following table gives the error records for the first fifteen trials for all the controlled groups. The asterisk indicates the error record made at the beginning of the post-controlled period. It is marked out so as to facilitate the comparison between this record and the corresponding one for the normal group.

The most efficient group is the one in which the subjects started at a more advanced stage of learning with the beginning of the uncontrolled period than did the normal group at the corresponding point (for instance, 0.9 *vs.* 2.9). The less efficient groups started at a comparatively less advanced stage (44.5 *vs.* 22.6 and 25.1 *vs.* 16.6).

TABLE 13

Error Records for the First Fifteen Trials

Trials	N	A-1-2	A-2-ab	A-8-a..h	A-12-a..l
1	78.2	27.6	33.8	25.4	24.7
2	22.6	44.5*	14.5	24.8	12.3
3	16.6	13.1	25.1*	12.3	23.8
4	20.3	12.1	17.1	5.5	10.9
5	6.3	7.5	5.2	3.9	7.3
6	13.0	9.4	2.9	2.0	4.4
7	6.3	2.8	2.3	1.8	5.4
8	5.6	3.1	1.7	1.8	4.3
9	2.9	1.9	1.9	0.9*	3.1
10	3.0	1.8	1.1	0.9	1.2
11	2.9	2.5	0.9	1.2	2.2
12	3.9	2.7	1.5	1.8	2.3
13	3.7	2.7	0.6	0.2	2.6*
14	2.8	0.4	0.8	2.0	1.2
15	2.1	0.6	0.4	0.3	1.6

The records for the final speed also throw some light on the discussion of the relative efficiency of the various controlled groups. There seems to be a negative correlation between the degree of efficiency and the speed of work. The most efficient group is the slowest group. The least efficient one gives the best speed record. Groups with the information given during a fewer number of trials are more efficient than the one in which the information is imparted to the subjects during a greater number of trials; the subjects in the former travelled much more slowly than those in the latter. These facts again confirm our contention that the low speed in the controlled groups as compared with the final speed for the normal group is due to the development of the attitude of caution on the part of the subjects in these groups, and that the information is responsible for the establishment of such an attitude.

The fact that the subsequent effect of the verbal information increases with the number of controlled trials and then decreases may be explained in the following manner: When the verbal information was given for one or two trials only, it could hardly be fixed in the subject's mind well enough to be utilized effectively in the subsequent uncontrolled trials. This difficulty became

greatly lessened, when the information was given in a greater number of trials. But when this number was greatly increased, the subjects developed an attitude of dependence upon the experimenter, and they were at a loss for a time after the control was removed. This setback naturally destroyed in part the subsequent beneficial effect of the information.

There is another reason why the information given for a fewer number of trials is comparatively more effective than that given for a greater number of trials. When a subject is told that he will receive aid during one or two trials only, he exerts more effort in them than if given a large number. On the other hand, when he knows that he will be given aid for a large number of trials, say twelve, he will distribute his effort in proportion to the number of controlled trials given. Naturally a subject will learn relatively more in two trials in the former case than he will in the latter. Inasmuch as about fifty percent of the total errors is usually made in the first two trials (48.25% for the four controlled groups and 53.05% for another three groups picked at random), the importance of these trials can not be overestimated. Hence, those who learn more during these trials make a better record than those who learn less. It may be argued that in the latter case the subjects can still learn in the controlled trials other than the first two, and the information received during these trials may influence the total record. This is quite true, provided that the number of these trials is not too great. That is why A-8-a...h is the most efficient group. But when the number of these trials becomes too great, the factor mentioned at the close of the last paragraph will operate to prolong the error record.

CHAPTER V

Effect of Information Given at Various Positions

The purpose of the experiments reported in this chapter is to study the effect of varying the position at which a given amount of verbal information is inserted.

Eight groups of subjects mastered the stylus maze under various conditions. Four groups each learned the maze with the information given during but one trial, viz., the first, second, fourth and sixth trials and they are designated respectively as A-1-a, A-1-b, A-1-d, and A-1-f. Four groups of subjects each learned the problem with the aid of the information during two trials, interpolated during the first and second, third and fourth, seventh and eighth, and eleventh and twelfth trials, and these groups are designated respectively as A-2-ab, A-2-cd, A-2-gh, and A-2-kl. Ten subjects each were employed for groups A-1-a, A-1-b, A-2-gh and A-2-kl, and fifteen subjects each for groups A-1-d, A-1-f, A-2-ab and A-2-cd. In each case the A form of verbal information was given. To each subject the amount of information and the position at which it was given were made known before the experiment was begun.

The results of these experiments were compared with those of the normal group of fifteen subjects who mastered the maze without the aid of information at any stage in the process of learning. The comparative data are shown in tables 14 and 15. Table 14 gives the gross records for all these groups, and table 15 gives the percentages of saving of each of the controlled groups over the normal group.

Three main problems may be suggested for discussion:

(1) Is a given amount of verbal information interpolated at various positions universally effective as a control?

(2) What is the position at which a given amount of verbal information produces the maximal effectiveness? What is the relative value of the various positions?

TABLE 14

Effect of Information Given at Various Positions

Groups	Trials	Errors			Errors per Trial	Final Speed
		Retr.	Blind	Total		
N	31.66 ± 9.33	67.4	138.7	206.1 ± 88.91	7.11	12.68 ± 1.64
A-1-a	20.9 ± 8.68	42.7	94.3	137.0 ± 83.60	7.08	18.70 ± 3.95
A-1-b	23.7 ± 5.96	44.7	98.9	143.6 ± 87.12	6.15	21.50 ± 4.25
A-1-d	23.4 ± 8.72	50.8	98.2	148.9 ± 54.88	6.51	19.38 ± 4.86
A-1-f	23.5 ± 9.70	40.0	87.3	127.3 ± 82.62	5.12	23.22 ± 10.24
A-2-ab	20.4 ± 7.54	34.8	74.7	109.5 ± 54.86	6.74	18.17 ± 4.24
A-2-cd	22.8 ± 9.22	41.7	82.7	124.4 ± 67.76	5.61	18.31 ± 4.44
A-2-gh	29.7 ± 8.16	42.8	117.8	160.6 ± 50.84	5.75	31.55 ± 10.45
A-2-kl	33.3 ± 11.3	55.3	109.9	165.2 ± 38.90	5.89	19.35 ± 2.38

TABLE 15

Percentages of Saving of the Controlled Groups

Groups	Trials	Errors	Final Speed
N	.....	.....	.....
A-1-a	33.98%	33.53%	—47.47%
A-1-b	25.14	30.33	—69.56
A-1-d	26.08	27.76	—52.92
A-1-f	25.77	38.24	—83.12
A-2-ab	35.56	46.92	—43.29
A-2-cd	27.98	39.65	—44.47
A-2-gh	6.19	22.08	—150.47
A-2-kl	—5.12	19.85	—52.65

(3) Does the optimal position remain unchanged irrespective of the amount of information given?

The factual results of the experiments reported in this chapter may be stated briefly as follows:

(1) Verbal information, regardless of the amount and the position at which it was given, was effective with one exception, in decreasing the total number of errors, the number of errors per trial, and the final speed for all the eight controlled groups.

(2) When the information was given during but one trial, its effect on the error records for the different groups was practically the same as that on the number of trials required to master the maze, with one exception. When it was given during two

trials, its effect on the error records was much greater than that on the trial records.

(3) Verbal information given at the initial position produced a greater effect upon the trial and error records than it did when given in any other position. This is true in all cases except one regardless of the amount of information imparted to the subject.

(4) With one exception, the information given at a later stage of the learning process was less effective upon the trial and error records than it was at an earlier stage. This is true whether the information was imparted to the subject during one trial or during two trials.

(5) There was no consistent tendency in the records for the final speed. No definite relationship between these records and the various positions at which the information was given was apparent.

(6) In general, the relative effect of the information upon the records for both the retracing and the *cul de sac* errors was practically the same.

(7) Information tended to increase the relative individual variability in the trial records in six out of eight cases, in the error record in five out of eight cases, and in the record for the final speed in all but one case.

(8) When the information was given during two trials, it produced a greater effect upon the trial and error records than it did when it was given during one trial in a similar position. This general statement is based upon comparisons between the results of group A-2-ab with those of groups A-1-a and A-1-b, and the results of group A-2-cd with those of group A-1-d in table 14.

The advantage of the controlled groups over the normal group may be further analyzed in terms of the immediate and the subsequent effects of the verbal information. These effects are shown in table 16, in which the number of errors per trial in the controlled and uncontrolled periods is compared with the corresponding data for the normal group.

For example, the group which received the information during the first trial (A-1-a) made an average error record of 27.60 per

TABLE 16

Immediate and Subsequent Effects of Verbal Information

Groups	No. of Errors per Trial in					
	Controlled Period			Uncontrolled Period		
	No.	Cor. No. in N	Saving	No.	Cor. No. in N	Saving
A-1-a	27.60	79.07	65.09%	5.5	4.1	—34.15%
A-1-b	8.20	22.66	63.81	3.4	3.5	2.85
A-1-d	7.70	20.26	61.84	2.6	2.4	—8.33
A-1-f	4.90	12.93	62.11	1.8	1.9	5.26
A-2-ab	24.26	50.86	52.28	3.3	3.5	5.96
A-2-cd	12.56	18.40	31.71	1.5	2.4	3.75
A-2-gh	5.25	5.93	11.46	2.1	1.5	—4.00
A-2-kl	2.55	3.40	25.00	1.4	1.3	—7.69

trial during the period in which the information was given, and an average record of 5.5 per trial during the subsequent uncontrolled period. The corresponding data for the normal group were 79.07 and 4.1. The percentages of saving and loss due to the operation of the information are 65.09 and —34.15 for the two periods.

The immediate effect of the information upon the error record, according to table 16, is always beneficial. The percentages of saving tend to decrease at first and then increase as the position at which a given amount of information is inserted is shifted towards the end of the learning period. This tendency is much more pronounced in the case in which the information is given during two trials than in the one in which it is given during but one trial.

The immediate effect of a greater amount of information is less than that of a smaller amount. But in general the subsequent effect of the former is greater than that of the latter.

The immediate effect of the information upon the error record is smaller when the information is given during the two trials than when it is given during either one of the two alone. The subsequent effect in the former condition is greater than that in the latter condition. These facts are borne out by comparing group A-2-ab with groups A-1-a and A-1-b, and group A-2-cd with group A-1-d with respect to their records for the immediate and the subsequent effect of the information (See table 16 for data).

The relative value of the various positions at which a given amount of information is inserted seems to be a function of the combined influence of the immediate and the subsequent effects of the information. When both the immediate and the subsequent effects are beneficial, the combined influence always operates to produce a better record than either one of them alone. When the immediate effect is beneficial, the degree of its effect does not necessarily determine the efficiency of the group. But when the subsequent effect is either beneficial or detrimental, it becomes the controlling factor in determining the value of a position at which a given amount of information is inserted. For example, among the four groups in which the information is given during one trial at various positions, group A-1-f made the least number of errors in the whole period of learning. This is due to the fact that the combined influence of the immediate and the subsequent effects is greater in this group than in any one of the other three. Among the four groups the immediate effect of the information upon the error record in group A-1-f is not so great as that in some other groups, but the subsequent effect in this group is greater than any, and hence it operated to produce the best error record for this group. On the other hand, among the four groups in which the information was given during two trials, group A-2-kl made the largest number of total errors. This is accounted for by the fact that the detrimental effect of the information upon the subsequent error record in this group is greater than that in any other group, e.g., group A-2-gh, although the immediate effect in group A-2-kl is actually greater than that in group A-2-gh.

The relative efficiency of the groups in five out of eight cases is determined by the records for the subsequent effect of the information. Only in one case (A-1-d), does the immediate effect seem to determine its relative standing.

That verbal information given during the initial trial or trials is more effective than it is when inserted nearer the end of the learning period can be explained by the fact that more errors are usually made during the first few trials than during the later ones, and hence the information has more chance to decrease the error record in the initial trials. Another possible reason for the superiority of

the initial position may be advanced. We may assume that the verbal information produces both a beneficial and a detrimental effect upon the error record. It is likely that the detrimental effect manifests itself to the least extent during the initial trials.

It will be remembered that in table 16 the percentages of saving during the control period decreases at first and then increases. This increase may be explained in this manner: When a subject has traversed the maze for a number of times, most of the errors are eliminated. A few persist for a number of trials, and the tendency to make the same set of errors is partly due to a lack of caution on the part of the subject. When the subject is told at this stage of learnnig that verbal information is to be given, he naturally pays more attention to his work, and this additional effort is responsible for the greater saving in the error records for the comparatively later group of trials during which the information is given.

The fact that the subsequent effect of the information upon the error records is sometimes beneficial and sometimes detrimental needs some explanation, which must differ for the various groups which received different amounts of verbal information. When the information is given during the first trial only, its immediate beneficial effect is very pronounced; but the effect is too transitory to be lasting. Moreover, the subject learns less in one controlled trial than in an uncontrolled one, because the latter permits greater freedom for exploration. This combined influence operated to produce the detrimental effect upon the subsequent error record for group A-1-a. On the other hand, when the controlled trial is shifted down towards the end of the learning period, the subsequent effect becomes more beneficial. This is also a product of two factors; the experience gained previous to the controlled trial plus the immediate beneficial effect make the subsequent effect of the information beneficial. However, group A-1-d is the exception to the rule. The detrimental effect in this case may be due to the operation of chance. In the four two-control groups, the subsequent effect of the information in the first two groups is beneficial. This is accounted for by the fact that the information given during the two trials at the initial positions tends to stay in the

mind of the subject so that he may utilize this knowledge to his advantage in the later trials. When the two controlled trials are moved down to the later positions, the subsequent effect becomes detrimental. The reason is this: When a subject has travelled around the maze for some ten times, he has developed a habit of going into certain *cul de sacs*. Here the verbal information tended to disrupt the old habit with a resultant confusion. Before the correct habit can be established, a considerable number of errors are made. This fact is responsible for the percentage of loss in the subsequent error records for group A-2-gh and A-2-kl.

CHAPTER VI

Effect of Various Distributions of Information

The purpose of this chapter is to study the relative efficiency of various distributions of a given amount of verbal information. In each of the experiments reported in the following pages the A form of verbal information was given in six trials distributed in various ways. In general, the various distributions fell in two main classes. (1) The amount of information interpolated at different positions was varied, while the number of the uncontrolled trials in between was kept constant. (2) The number of the uncontrolled trials between the controlled ones was varied, while the amount of information interpolated at different positions was kept constant.

Five groups of ten subjects each were employed in the experiments. The plan of experimentation is evident from the following schema:

(1) The amount of information given at various positions is varied:
A-6-a..de..hij
A-6-ab..ef..ij
A-6-abc..fg..j

(2) The number of uncontrolled trials between the controlled ones is varied:
A-6-ab..ef..ij
A-6-ab...fg...kl
A-6-ab....gh....mn

In the above schema, 'A' indicates that the A form of verbal information was employed; '6,' the number of trials during which the information was given; 'abcd...,' the positions at which the information was inserted. Thus, A-6-a..de..hij means that the A form of verbal information was given for six trials during the first, fourth, fifth, eight, ninth, and tenth trials.

The results of these groups are compared with those of the normal group of fifteen subjects who learned the maze without

the aid of any information. The comparative data are given in tables 17 and 18. Table 17 gives the gross data for these groups and the percentages of saving due to the information. Table 18 shows the immediate effect of the information for the various positions.

TABLE 17

Effect of Various Distributions of Information

Groups	Trials		Errors		Final Speed	
	No.	Saving	No.	Saving	No.	Saving
N	31.6	.....	206.1	.....	12.68	.....
A-6-a..de..hij	25.3	20.08%	151.4	26.55%	23.00	—81.41%
A-6-ab..ef..ij	21.2	33.03	147.0	28.68	24.40	—92.43
A6-abc..fg..j	21.4	32.41	105.8	48.57	28.10	—121.61
A-6-ab...fg...kl	20.5	35.24	88.3	57.16	28.42	—124.12
A-6-ab....gl....mn	21.6	31.77	139.0	32.56	25.57	—101.65

TABLE 18

Immediate Effect of Information for Various Positions

Groups	Contr. Trials	Errors	Corresp. Errors in N.	Saving
A-6-a..de..hij	1	22.3	79.07	71.79%
	4-5	20.0	26.26	23.93
	8-9-10	12.8	11.46	—11.69
A-6-ab..ef..ij	1-2	50.2	101.27	48.68
	5-6	18.8	19.28	1.97
	9-10	13.1	5.20	—151.92
A-6-abc..fg..j	1-2-3	66.9	118.27	43.43
	6-7	5.4	19.20	71.87
	10	3.5	3.13	—11.82
A-6-ab...fg...kl	1-2	35.0	101.72	65.59
	6-7	6.8	19.20	64.58
	11-12	3.6	6.86	47.52
A-6-ab....gh....mn	1-2	50.8	101.72	50.05
	7-8	8.6	11.86	27.48
	13-14	4.9	6.26	21.72

The factual results of the experiments reported in this chapter may be summarized as follows:

(1) Verbal information, whatever the way it was distributed,

was universally effective in decreasing the number of trials required to master the maze, the number of errors made in the entire learning period, and the final speed.

(2) On the whole, it affected the records for the final speed most, the error records next and the trial records least.

(3) With one exception, the effect of the information on the trial records for all the groups was practically on a par. This tendency did not exist in the scores for error and final speed.

(4) When the amount of information given at various positions was varied and the number of the uncontrolled trials between positions was constant, the group which received the largest amount of information during the initial trials was in general the most efficient, *i.e.*, A-6-abc..fg..j.

(5) When the number of the uncontrolled trials between the controlled ones was varied, and the amount of information given at various positions was constant, the groups which had the information given during two trials at a time with three uncontrolled trials in between was the most efficient one, *i.e.*, A-6-ab...fg...kl

(6) When all the different distributions were taken into consideration, the best distribution of the six trials consisted of two controlled trials given at a time with three uncontrolled ones in between.

(7) With one exception, the information given during the initial group of trials exerted the greatest immediate effect upon the error records, while the least effect was invariably produced by the last group (See table 18).

The relative efficiency of the different distributions of a given amount of verbal information is a function of its immediate and subsequent effects. When both the immediate and the subsequent effects are beneficial, the combined influence tends to produce a better record than either one of the two would alone. When one of them is detrimental, it determines the efficiency of the distribution. These facts are shown in table 19, in which the immediate and the subsequent effects are stated in terms of the percentages of saving or loss of each of these groups in respect to the normal group.

Thus, among the groups in which the amount of information

TABLE 19

Immediate and Subsequent Effects of Information

Groups	No. of Errors per Trial in					
	Controlled Period			Uncontrolled Period		
	No.	Cor. No. in N	Saving	No.	Cor. No. in N	Saving
A-6-a..de..hij	9.20	19.46	52.72%	4.9	3.5	—40.00%
A-6-ab..ef..ij	13.71	21.15	35.22	4.2	3.1	—35.49
A-6-abc..fg..j	12.20	23.27	47.57	2.1	2.5	16.00
A-6-ab...fg...kl	7.57	21.13	64.17	2.9	3.1	6.45
A-6-ab....gh....mn	12.40	19.97	37.91	4.8	3.4	—41.18

given at various positions is varied and the number of the intervening uncontrolled trials is constant, group A-6-abc..fg..j is the most efficient, because of the beneficial effects of the information, both immediate and subsequent. Group A-6-ab..ef..ij is more efficient than group A-6-a..de..hij, because the detrimental subsequent effect of the information in the latter is greater than that in the former. Similarly, among the groups in which the number of the uncontrolled trials between the controlled ones is varied and the amount of information given at various positions is kept constant, groups A-6-ab...fg...kl is the most efficient, because both the immediate and the subsequent effects of the information are beneficial. Group A-6-ab..ef..ij is more efficient than group A-6-ab....gh....mn, because the detrimental effect of the information upon the subsequent uncontrolled trials in the former is smaller than that in the latter.

The relative efficiency of these groups may also be measured in terms of the records for the final speed. The most efficient groups are those whose subjects perform the task with much deliberation and hence with lower speed. Among the three groups in which the number of the uncontrolled trials between the controlled ones is varied, group A-6-ab...fg...kl is the most efficient. The subjects in this group travelled slower than those in any other group. Similarly, group A-6-abc..fg..j is the most efficient among those in which the number of the controlled trials is varied at various

positions and it exhibits a comparatively low speed record. When all the controlled groups are taken into consideration, it has been shown that group A-6-ab . . . fg . . . kl is the most efficient, and the final speed for this group is lower than that for any other group.

CHAPTER VII

Effect of Information Concerning Types of Error

In this chapter we shall study the effect of giving verbal information concerning the various types of error upon learning the maze. Three groups of fifteen subjects each mastered the maze under different conditions. The members of group X were informed only of each *retracing* error as they made it; those of group Y, of each *cul de sac* error; and those of group A (the same group reported in Chapter III), of *both types* of error. In all cases the information was imparted to the subjects during every trial involved in learning the maze.

The results of these groups were compared with those of the normal group of fifteen subjects who learned the maze without any kind of information concerning their errors. The comparative data are given in table 20 in terms of the total number of trials, the retracing and the *cul de sac* errors, the total number of errors and the final speed.

TABLE 20

Effect on Information Concerning Types of Error

Groups	Trials	Errors			Final Speed
		Retracing	Cul de sac	Total	
N	31.66	67.4	138.7	206.1	12.68
X	37.80	46.1	140.2	186.3	21.32
Y	23.07	62.1	96.2	158.3	21.15
A	22.27	28.8	74.4	103.2	21.81

The factual results of these experiments may be summarized as follows:

(1) Verbal information operated to decrease the records for the total number of errors made during the entire period of learning and to increase the records for the final speed in all cases. It decreased the total number of trials required to master the maze in all but one case.

(2) When the subjects were informed of one type of error

only (be it retracing or *cul de sac*), they made poorer records for the total number of trials, the retracing and the *cul de sac* errors, and the total number of errors than did those who received information concerning both types of error. The records for the final speed are practically on a par in the two cases.

(3) Information concerning the *cul de sac* errors produced a more beneficial effect upon learning the maze than did that concerning the retracing errors. The former tended to decrease the total number of trials, while the latter exhibited the opposite tendency.

(4) Information concerning the retracing errors cut down the retracing errors but not the *cul de sac* errors, while that concerning the *cul de sac* errors decreased the total number of *cul de sac* errors but not the retracing errors.

That the results of group A are superior to those of either group X or group Y is too obvious to require any explanation. So also is the fact that the error records for groups A, X and Y are superior to that for the normal group.

The superiority of the trial records for the groups A and Y over that for the normal group may be accounted for by the low error records for the former groups.

The fact that the trial record for group X is inferior to that for the normal group needs explanation. Several possibilities may be advanced:

(1) The inferior trial record for group X may be due to the operation of chance. But this is hardly probable. In table 21 the distribution of the individual trial records for each group is giv-

TABLE 21

Distribution of Individual Trials

Groups	Individual Trial Records														
N	17	18	19	24	24	26	29	*29*	37	38	39	39	39	45	62
X	20	22	23	24	25	31	32	*33*	36	45	49	49	52	61	65
Y	10	12	15	16	16	18	21	*22*	23	23	24	24	32	41	49
A	8	9	12	13	17	18	19	*20*	22	25	26	28	30	41	46

en. It will be seen that group X has just as consistent a distribution of the individual trial records as that of any one of the other three groups. It starts higher and ends higher than any other one; also it has the highest median (33) among the four. The high trial record, then, is not due to any one unusually large individual record.

(2) The inferiority of the trial record for group X may be due to a change of attitude on the part of the experimenter toward the subjects. This is not likely the case, because groups X and Y were run simultaneously. Were there such a change of attitude on the part of the experimenter, it would have affected the results of group X as well as those of group Y.

(3) A third possible explanation may be given in terms of the attitude of the subjects. In group X the subjects soon developed the habit of relying upon the experimenter for the information concerning the retracing error. This attitude of dependence on the part of the subjects actually delayed the complete elimination of the retracing errors. Thus, in the normal group the habit of the subjects of retracing the correct pathway was dislodged on the average by the end of the eighteenth trial, while the same habit persisted in group X to the end of the twenty-second one. Inasmuch as the elimination of the retracing errors was usually completed long before that of the *cul de sac* errors, this delay in completing the elimination of the retracing errors also postponed the complete elimination of the *cul de sac* errors. Hence, the trial record was prolonged.

(4) Since in group X the attention of the subjects was called to the retracing errors alone, naturally they were more cautious about them than about the *cul de sac* errors. This insufficiency of attention given to the latter was responsible not only for the delayed final elimination of the *cul de sac* errors but also for their large number. Thus, the number of the *cul de sac* errors in the normal group was 138.7, while that in group X was 140.2. This high record for the *cul de sac* errors together with the consequent postponement of their final elimination may account for the high trial record.

(5) The knowledge obtained from the information concerning

the retracing errors is much less definite than that of the *cul de sac* error. Information concerning the retracing error often gives rise to confusion on the part of the subjects resulting in uncertainty in their work. Such confusion not only favors the rise of errors but also gives occasion for them to persist. Both these factors tend to produce a high trial record.

Whatever the explanation one may adopt, the fact remains that information concerning the retracing errors when given alone tends to prolong the trial record.

It is also significant to note that information concerning the *cul de sac* errors is more beneficial in learning the maze than that concerning the retracing errors. The former exerts a beneficial influence on both the trial and error records, while the latter proves detrimental to the trial record and beneficial to the error record only to a very limited extent.

CHAPTER VIII

Instructional vs. Informational Methods of Tuition

In the previous chapters we have studied the effect of two different methods of tuition upon maze learning: (1) The Instructional method by means of which the subject is guided over the correct pathway and all possibility of errors is prevented and (2) the Informational method in which the subject is informed of each error as it is made. The influence of the former was studied in Chapter II and that of the latter in Chapters III-VI inclusive.

This chapter is concerned with a comparison of the relative efficiency of these two forms of tuition in acquiring an act of skill. Only three groups were given comparable amounts of tuition by the two methods, viz., those to whom the tuition was given for the first trial, the first two trials and the initial eight trials. The comparative data presented in table 22 were calculated in terms of the superiority of the method of Instruction. For example, group D-2-ab which was given instructions during the first two trials made a better record than did group A-2-ab which was given a similar amount of Information. Group D-2-ab was superior to group A-2-ab by 6.69% in trial, 55.74% and 45.38% respectively in retracing and *cul de sac* errors, and 66.62% in the number of errors per trial. It was inferior to group A-2-ab by 18.63% in final speed.

TABLE 22

Instructional vs. Informational Methods of Tuition

Groups	Trials	Errors		Errors per Trial	Final Speed
		Retrac.	Blind		
D-1-a vs. A-1-a	—4.78%	22.95%	27.14%	41.82%	—27.23%
D-2-ab vs. A-2-ab	6.69	55.74	45.38	66.62	—18.63
D-8-a..h vs. A-8-a..h	35.46	58.73	61.33	75.89	— 2.91

These data justify the following conclusions:

(1) With one exception, the Instructional Method of tuition

is the more effective upon the scores for trials, the two kinds of error, the average number of errors per trial and the final speed.

(2) Its relative efficiency increases with the amount of instruction given.

The superiority of the instructional over the informational method of tuition in the trial and error records may be explained in several ways: (1) The absence of error when the instructional method was employed—In the groups in which the instructional method was employed, the subjects had no chance to make any error during the controlled trials. In those to whom the information was given during a given number of trials, the subjects did make a number of errors during the controlled period. This difference operates to decrease the error for the instructional method. (2) The kind of knowledge of the maze—Verbal instructions give the subjects a knowledge of the correct pathway, while verbal information aids them in the discovery of the errors. The former is a case of positive guidance, while the latter is one of negative assistance. It is a common sense pedagogical principle that positive instruction is always more effective than negative assistance.

The fact that the instructional groups exhibited a lower speed record than the informational groups can be explained in terms of the degree of caution on the part of the subjects. The instructional method seemed to induce within the subjects a more cautious attitude than did the informational method. With the former method the subjects acquired a knowledge of the correct pathway but not of the *cul de sacs*. Consequently, conscious of this deficiency, they worked very carefully and hence slowly. With the latter method, the subjects acquired a knowledge of both. With a certain degree of familiarity of the paths of the maze, they travelled over them with comparatively less hesitancy and higher speed than those who worked with the former method.

CHAPTER IX

Incidental Observations

The incidental observations reported in this chapter are the by-products in the general inquiry concerning the influences of tuition upon learning a stylus maze. These observations will be treated in the most summary fashion under the following topics: (A) Individual differences, (B) Sex differences, and (C) Order of elimination of the *cul de sac* errors.

(A) Individual Differences—Under this topic there will be studied individual differences (1) as indicated by the various criteria of learning, (2) in the order of error elimination, and (3) in the modes of attacking the problems.

(1) Individual differences as indicated by the various criteria of learning—Individual differences within one group are compared with those in the other groups with reference to their records for trial, error, and final speed. These comparative data are given in table 23, in which each value represents the extreme range of individual differences within any one group expressed in terms of the percentage of the poorest over the best. For example, the poorest record in the normal group is worse than the best by 360% in trial, 420% in error and 150% in final speed.

The facts in this table justify the following conclusions:

(a) In a comparison of the range of individual differences within each of the twenty-one groups with that of the normal group, thirteen are found to show greater variability in trials, seventeen in errors, and twenty-one in final speed. Tuition, in general, increased the extreme range of individual differences within a group.

(b) With the exception of the records for the final speed, the range of individual differences within the group is on the whole smaller in the D groups (Instructional Method) than in the A groups (Informational Method).

(c) In general, individuals differ most widely in errors, next in trials, and least in final speed.

TABLE 23

Individual Differences as Indicated by Various Criteria of Learning

Groups	Subjects	Trials	Errors	Final Speed
N	15	360%	420%	150%
D-1-a	10	250	272	1070
D-2-ab	10	520	580	320
D-4-a—d	10	410		610
D-8-a..h	10	330	393	350
D-16-a..p	10	210	640	520
A	15	570	1540	450
A-1-a	10	510	1130	270
A-2-ab	15	400	1640	290
A-8-a..h	15	270	1510	330
A-12-a..l	10	460	2330	220
A-1-b	10	340	1330	220
A-1-d	15	420	1790	290
A-1-f	15	600	2520	610
A-2-cd	15	690	2320	270
A-2-gh	10	600	470	420
A-2-kl	10	430	420	190
A-6a..de..hij	10	430	550	390
A-6-ab..ef..ij	10	310	730	310
A-6-abc..fg..j	10	180	300	370
A-6-ab...fg...kl	10	220	510	310
A-6-ab....gh....mn	10	530	1220	160

(2) Individual differences in error elimination—An examination of 86 records shows that various *cul de sacs* attracted individuals differently. The following table gives the *cul de sacs* eliminated first and last (as indicated by the figures in the first row). The figure opposite each *cul de sac* indicates the number of persons who eliminated that *cul de sac* error in the same temporal order. The asterisk shows the greatest number of persons who eliminated a *cul de sac* error in the same order.

From this table it is evident that (1) individuals differ much more greatly in the *cul de sac* errors which are eliminated first than those eliminated last, and (2) the tendency to eliminate the *cul de sacs* G and E last is very marked.

(3) Individual differences in the mode of attacking the problem—As observed individuals seem to have different methods of learning the maze. The following are typical: (a) The maze pattern was visualized in the first few trials and the visual image of

TABLE 24

Showing Cul-de-sacs Eliminated first and last

Cul de sacs		1st	2nd	15th	16th
Goal	E'†	5	1	11	7
End	F'	11	10		1
	G'	16	7		
	H'	17	5		
	H	7	16*	2	2
	A'	21*	2		1
	B'	4	3	10	14
	C'	11	9		
	G	1	7	18*	24*
	F	10	13	2	
	E	1	3	30*	21*
	D'	9	6	13	2
	D	10	12	3	2
	C	18	15*		
Entr.	B	14	14		
End	A	22*	13		

† E'=*Cul de sac* on the other side of E; F', the other side of F; etc.

the pattern was employed as a guide in the subsequent ones. (b) The arm movements employed in learning were remembered. Some of the subjects discovered that the movements for the two halves of the maze were almost identical and that those employed in the center were of the stair-case fashion. Some mastered the maze (c) by being able to judge the distances between the sections of the correct path; others (d) simply remembered the exact direction to go to the goal end. (e) Several went through the maze correctly by being able to remember against which side of the groove to lean the stylus. (f) A number of them were able to keep the stylus in the right groove by remembering the number of sections traversed. No attempt has been made to correlate the modes of attack and the efficiency of the work. It is probably a matter of individual preference. A method employed advantageously by one may be adopted by the other to his utter disadvantage.

(B) Sex differences—The facts about sex differences are summarized in the following table in which the figures in the brackets indicate the number of cases which goes to make up the average.

TABLE 25

Sex Differences

Criteria	N		A		D	
	M (8)	F (7)	M (120)	F (70)	M (36)	F (14)
Trial	31.75	31.57	117.59	25.67	22.42	29.07
Error	176.59	226.71	21.83	144.65	36.61	75.64
Fin. Speed	11.50	13.37	21.61	22.31	24.40	25.47

On the whole women made a poorer record than men. The greatest difference is in the error record and the smallest in the record for the final speed. A greater sex difference exists in the D-form than in the A-form of tuition. These differences, however, may be due to the comparatively small number of records for women.

(C) Order of elimination of the *cul de sac* errors—In the study of the individual differences in the order of elimination of the *cul de sac* errors, we were impressed by the fact that there was no definite relationship between the spatial order of the *cul de sacs* and the temporal order of their elimination so far as the four cases there considered were concerned (see table 24). In order to substantiate this statement 86 records were studied with reference to the order of elimination of all the sixteen *cul de sac* errors. The results are shown in table 26, in which each figure represents the average of 86 records.

TABLE 26

Relationship between Spatial Order of Cul de Sacs and Temporal Order of Their Elimination

Order fr. Entrance	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Blind Alley	A	B	C	D	D'	E	F	G	C'	B'	A'	H	H'	G'	F'	E'
Order of Eliminat.	3	7	1	9	13	15	5	16	6	14	10	11	2	4	8	12

Our results do not support the contention of a backward elimination of the *cul de sac* errors; nor do they give evidence for any current theory of error elimination in the maze. On the contrary, they seem to indicate that the temporal order of the elimination of the *cul de sac* errors is a function of the nature or the peculiar

position of the *cul de sacs*. *Cul de sacs* C, A, G′ and H′ (see Fig. 1) were eliminated first because they were more or less out of the way with respect to the correct pathway. *Cul de sacs* G, E, B′ and E′ were eliminated last, because they occupied peculiarly attractive positions. *Cul de sac* E is located at the end of a comparatively short runway perpendicular to a very long section of the correct pathway. On emerging from this long section, the subjects usually over-estimated the distance of this short runway ending in *cul de sac* E. Hence, instead of going into the opening to the correct pathway, which was a little distance from E, they usually passed over this opening and made an error at E. A similar explanation can be given for the frequent entrance into the *cul de sacs* G, B′ and E′.

Another interesting fact may be noted in connection with the study of the temporal order of elimination of the *cul de sac* errors. The initial and final errors were eliminated first. This seems to follow the general law in memory work, that the material at the two ends of a series is always mastered first.

CHAPTER X

Summary and Conclusions

In this study of the influence of tuition upon learning a stylus maze, two forms of tuition were employed; namely, the method of verbal instruction and the method of verbal information.

Without a single exception, tuition operated to decrease the number of errors made during the entire period of learning and the average final speed employed to travel through the correct pathway. It operated to decrease the total number of trials required to master the maze in twenty-one out of twenty-three cases. The decrease of the error records due to the operation of tuition was obvious. That tuition operated to decrease the final speed was explained by the fact that it induced in the subjects the attitude of caution, which meant slow movement. This attitude of caution induced by the tuition seemed to be the reason for the effectiveness of tuition in learning.

Without exception tuition affected the records for the final speed most, the error records next, and the trial records least.

The effect of tuition on the retracing errors was invariably greater than that on the *cul de sac* errors.

Of the two forms of tuition employed in this investigation, the instructional method proved to be more effective than the informational method.

Of the three forms of verbal information employed, method C (naming each error by the experimenter after it was made) was slightly more efficient than methods A and B. The differences between them were too small to be significant. Method A was, however, chosen for the various investigations of the effect of the verbal information upon learning the maze, because it was easily administered.

In the study of the effect of various amounts of tuition upon learning the maze, it was brought out that the effectiveness at first increased and then decreased, as the number of the controlled trials was increased. This was true for both the methods of instruction and that of information. In the former the number of

controlled trials that produced the optimal effectiveness was four, while in the latter it was eight. The reason for the increase of the efficacy of tuition at first is self-evident. The decrease of its effectiveness after the optimal number of controlled trials was reached has been explained in terms of the amount of tuition given in addition to the optimal amount. This additional amount was considered to be superfluous. Superfluous trials necessarily increase the trial and error records. Any excessive amount of tuition is apt to develop either an attitude of over-confidence or a habit of dependence upon the experimenter, both of which are responsible for the high trial and error records.

When a given amount of verbal information was imparted at various positions, the initial position was found to be the most effective. This is true irrespective of the amount of information imparted to the subjects. The relative value of the various positions seems to be a function of the combined influence of the immediate and the subsequent effects of the information upon the error records. The maximal effectiveness of the information at the initial position was explained in two ways: (1) The information gave more chance to decrease the errors, since more errors were usually made during the initial trials than during the subsequent ones. (2) It was assumed that the information, capable of producing both beneficial and detrimental effects upon the error records, tended to exert the greatest beneficial and the least detrimental influence during the initial trials.

When the verbal information was given during six trials distributed in various ways, the best distribution was found to consist of two controlled trials given at a time with three uncontrolled ones in between.

When the subjects were informed of one type of error only (be it retracing or *cul de sac*), they made poorer records for the total number of trials, the retracing and the *cul de sac* errors, and the total number of errors than did those who received information concerning both types of error. The records for the final speed are practically on a par in the two cases.

Information concerning the *cul de sac* errors produced a more beneficial effect upon learning the maze than did that concerning

the retracing errors. The former exerted a beneficial influence on both the trial and error records, while the latter proved detrimental to the trial record and beneficial to the error record only to a very limited extent.

The superiority of the instructional over the informational method of tuition on the trial and error records has been explained in terms of (1) the absence of errors when the former method was employed, and (2) the nature of the tuition, *i.e.*, positive guidance *vs.* negative assistance, the former being naturally more effective than the latter. The superiority of the informational groups over the instructional groups in the scores for the final speed was explained in terms of the degree of caution induced by the two forms of tuition. The instructional form induced within the subjects a more cautious attitude than the informational form, because the former gave them a knowledge of the correct pathway only, while the latter enabled them to obtain this and also a general knowledge of the *cul de sacs* entered.

Marked individual differences existed in all the experiments reported in this investigation. In general, individuals differ most widely in errors, next in trials and least in final speed.

Sex differences in the ability to learn the maze were not very pronounced. On the whole, women made a slightly poorer record than men.

There was no definite relationship between the spatial order of the *cul de sacs* and the temporal order of their elimination. The temporal order of elimination of the *cul de sac* errors seems to be a function of the peculiar position of the *cul de sacs* in the maze. In general, it was found that the *cul de sacs* at both the entrance and the goal ends were eliminated first.